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GRAIN INSPECTION HANDBOOK
BOOK I
Probe Sampling
7-07-95

CHAPTER 2

PROBE SAMPLING

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2.1 EQUIPMENT

- a. Probe. Probes, sometimes referred to as triers, are constructed of brass or aluminum and come in various sizes, with standard lengths of 5, 6, 8, 10, and 12 feet. The depth of the carrier or container dictates the length of probe that is used to draw the sample.
- (1) Probes consist of two tubes, one inside the other. The inner tube is divided into compartments. Depending on its length, a probe may have 11, 12, 16, or 20 compartments. The outer tube has slots which match the compartment openings of the inner tube.
 - (2) When the slots in the tubes are aligned, grain can enter into and be emptied from the compartments.

Carriers	Probe Lengths	Compartments
Barges and Bay Boats	12-foot	20 compartments
Hopper Cars	10- or 12-foot	20 compartments
Boxcars	6-foot	12 compartments
Trucks	5- or 6-foot	11 or 12 compartments
Hopper-Bottom Trucks	6-, 8-, or 10-foot	12, 16, or 20 compartments
Other Containers - Use grain probes that will reach the bottom of the container.		

Figure 1. Grain Probes and Carrier Types

NOTE: Non-compartmented grain probes and open-ended grain probes are not approved for official sample-lot inspections but may be used for official commercial inspection.

- (3) Whenever the bottom of a carrier/container is not reached by **all** probes, show the special statement "Top ____ feet sampled. Bottom not sampled." on the sample ticket. The number of feet shown in the statement shall correspond to the **estimated average depth** of all probes that **did not** reach the bottom of the carrier.

FOR EXAMPLE: A sampler is unable to reach the bottom of a hopper car compartment after inserting the probe to its full 10-foot depth. The bottom of the next compartment is not reached after the probe is inserted 8 feet. In the last compartment, the probe reaches the bottom after being inserted 9 feet. Since the bottom of the container was not reached with all probes, add the depth of the two probes that did not reach the bottom (8 feet + 10 feet = 18 feet); then divide by the sum (18 ÷ 2 = 9 feet). Show "Top 9 feet sampled. Bottom not sampled." on the sample ticket.

b. Sampling Canvas or Cloth.

- (1) Sampling canvases, which are usually made of flat duck cloth or similar material, must be longer than the probe used to draw the sample. This "extra length" is needed so that the grain from the entire length of each probe may be placed on the canvas and examined without being spilled.

NOTE: Always keep sampling canvases clean, dry, and free of holes.

- (2) Half sections of pipe or troughs (e.g., rain gutters) may be used instead of sampling canvases. Troughs must be longer than the probe used to draw the sample.

c. Sample Bags. Sample bags must be constructed from heavy cloth or canvas, have a draw string closure, and should be large enough to contain up to 4,000 grams of grain.

- (1) Sample bags shall be free of all old grain, insects, and foreign material.
- (2) To prevent a change in moisture or odor, it is recommended that a plastic liner be inserted inside the sample bag. The sample ticket or other records should be inserted between the liner and the bag, not directly in the sample.
- (3) Containers, such as metal buckets or plastic cans, may be used instead of sample bags provided the containers are clean and dry.

Sampling Canvases	Sampling Bags
30 inches X 5½ feet	8 inches X 16 inches
30 inches X 6½ feet	8½ inches X 19 inches
30 inches X 10½ feet	9 Inches X 16 inches
30 inches X 12½ feet	10½ inches X 16½ inches

Figure 2. Standard Sizes of Sampling Canvases and Bags

2.2 GENERAL PROCEDURES¹

a. Prior to Sampling.

- (1) Record the carrier's identification number on the sample ticket.
- (2) Break any seals that secure hatches or doors that must be opened. Record the prefix code number of broken seals on the ticket.
- (3) Open the hatches/doors and enter the carrier.

NOTE: **The applicant for inspection is responsible for removing truck tarps, opening roll-top barges, and trimming (leveling) the grain in the carrier.**

- (4) After entering the carrier, visually examine the top of the grain for any debris, lumps, glass, and other harmful material. Take a handful of grain from several locations and check it for odor. Record any unusual conditions or off-odors on the sample ticket.
- (5) Next, spread the canvas on a level surface. Make sure the probe and canvas are clean and dry.

b. Drawing the Sample. For each type of carrier, there is an established sampling pattern (see section 2.4 of this chapter). Probe the carrier in the areas identified for the particular type of carrier. There are many techniques for using a probe. Regardless of which technique is used, follow these general rules to obtain a representative sample:

- (1) Insert the probe at a 10-degree angle from the vertical, with the slots facing

¹Official agency managers, in cooperation with local FGIS field office managers, may modify these procedures, when deemed necessary. See Appendix 1, **Local Quality Control Programs**, for additional information.

upward and completely closed. Keep the slots closed until the probe is inserted as deeply as possible into the grain. If the slots are not kept closed, a disproportionate amount of grain from the top of the lot will fall into the probe's compartments as it is being inserted.

- (2) If the grain contains sand or grit, it is permissible to insert the probe with the slots facing downward to avoid "freezing" the probe. After the probe is inserted, turn the slots upward before opening.

NOTE: **At the discretion of the official agency or field office manager, nonlicensed personnel may assist official personnel in obtaining samples, provided that: (1) all nonlicensed personnel are under the direct, physical supervision of official personnel at all times; (2) the ratio of official personnel to nonlicensed personnel is reasonable and practical; and (3) official personnel determine the general condition of the grain and whether additional samples are needed due to quality differences.**

- (3) After the probe is fully inserted (with the slots facing upward), open the slots and move the probe up-and-down in two quick, short motions. When sampling grains, such as oats and barley, additional up-and-down movements may be necessary to fill the probe.
- (4) Close the slots completely. Then, grasp the probe by the outer tube and withdraw it from the grain.

CAUTION: **Do not pull the probe by the wooden handle. This can cause the inner tube to be pulled out of the outer tube. When this occurs, the probe must be emptied, reassembled, and the area re-probed.**

- (5) Empty the probe on the canvas and compare the grain in each compartment for uniformity of kind, condition, and infestation. Also, compare the sample to others drawn from the same lot. If all samples and portions of samples are uniform with one another, composite them in a sample bag with a completed sample ticket.

NOTE: **When using a trough, examine the grain in each compartment before emptying the probe sample into the trough.**

- (6) If the examination of the individual probe samples indicate that the grain is not uniform in condition (i.e., part of the lot is musty, sour, or heating), a sample from each of the different parts--in addition to a sample that represents the carrier as a whole--must then be drawn. See section 2.3 of this chapter.
- (7) When transferring the sample from the canvas to the sample bag, take care not to spill any portion of the sample or allow fine material to be blown away.
- (8) After placing the sample and completed sample ticket into the sample bag, tighten the drawstrings at the top of the bag so that it is closed securely. Carefully remove the bag from the carrier so that none of the sample is lost or spilled.

CAUTION: **Do not throw or drop the sample to the ground.**

- (9) Close all hatches or doors. Then, replace all broken seals with new seals--unless directed by the applicant for inspection not to do so. Record the prefix code and number of all seals applied on the sample ticket.

2.3 CARRIERS CONTAINING INFERIOR PORTIONS

- a. One of the most common errors in sampling is failing to obtain the required number of samples from a lot that appears to contain an inferior portion; e.g., musty, sour, or heating grain.
- b. Whenever a lot appears to contain an inferior portion, the sampler must draw **three** separate samples: a sample of the entire lot, a sample of the inferior portion, and a sample of the remainder of the lot. The absence of any one of these samples gives the inspector an incomplete picture of the grain in the carrier.

NOTE: **Each of the three samples must contain a minimum of 2000 grams of grain and be accompanied by a completed sample ticket.**

- c. Draw the three samples as follows:
 - (1) First, determine the boundaries of the inferior portion. This is done by repeated sampling and examination of individual probe samples.
 - (2) Once the boundaries have been found, draw a sample of the inferior portion, a sample of the remainder, and a sample of the entire lot.
 - (3) Estimate the approximate amount of grain represented by each sample and note the location of the grain in the carrier. The estimate is made using fractional parts, such as $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$, to indicate the portion of the lot represented by each sample. The probe can be useful in performing this task.
 - (a) To form a fraction using the probe, count the number of compartments containing the inferior grain and place that number over the total number of filled compartments.
 - (b) Reduce the fraction to its lowest form. This is the fractional part containing the inferior grain.
 - (c) Show this information, with a rough diagram of the portions, on the respective sample ticket completed for each sample.
 - (d) Note on the sample ticket the location of the inferior portions of grain in terms such as: Hopper cars - B-1 (the bay or compartment closest to the brake end), B-2 (the middle hopper), B-3 (the compartment opposite the brake end); and Barges - stern end, bow end, port, or starboard.

FOR EXAMPLE: An inferior portion has been found in a truck-lot of grain. Numbers 1, 2, 3, 4, 5, 6, and 7 represent the regular probe pattern. The letters a, b, c, d, e, f, g, h, i, and j represent additional probes taken. This should give the sampler an indication of the size and location of the inferior portion. However, if you believe that more samples are needed, then they should be taken. The proper procedure for estimating the fractional portions of inferior grain in the lot is to count the compartments of good grain and the compartments of inferior grain. Show the count on the back of the sample ticket.

F	1	a	2	b	3	c
R						
O-	d	e	f	4	g	h
N						
T	i	5	j	6	k	7

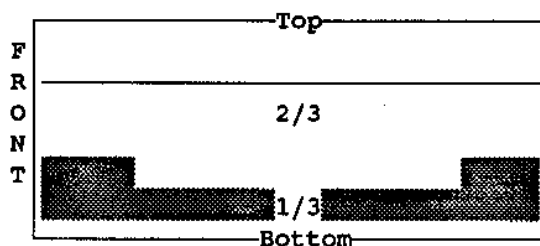
F	8/4	8/4	9/3	9/3	8/4	7/5
R						
O-	8/4	8/4	9/3	9/3	8/4	8/4
N						
T	7/5	8/4	8/4	8/4	7/5	7/5

Example: The procedure for computing the fractional portion of inferior grain in the lot is as follows: There are 144 compartments of sound grain and 72 compartments of inferior grain, total compartments in 18 probes using a 6 foot probe is 216.

$$\frac{144}{216} \div 4 = \frac{36}{54} \div 18 = \frac{2}{3} \quad 2/3 \text{ of the lot consists of good grain.}$$

$$\frac{72}{216} \div 4 = \frac{18}{54} \div 18 = \frac{1}{3} \quad 1/3 \text{ of lot consists of inferior grain.}$$

The drawing for the above lot would be similar to the one shown below.



NOTE: The aforementioned procedure may be modified and used to estimate inferior portions on all carriers sampled with a probe.

2.4 SAMPLING PATTERNS¹

- a. The following diagrams show the standard sampling patterns. Each lot shall be probed in as many additional locations as are necessary to assure that the sample is the required size and representative of the lot.
- (1) Additional probes shall be drawn in a balanced manner. For example, one compartment of a hopper car shall not be probed twice unless the other compartments are also probed twice, regardless of the amount of grain in any one compartment or the amount of additional sample needed.
 - (2) The sampling patterns in this section shall be used by all official inspection personnel when sampling grain at rest. Insert the probe at the points marked (X), with the tip of the probe pointed toward the direction of the arrow head. When two arrow heads are shown, the tip of the probe may be pointed in either direction.
- b. Sampling Patterns for Barges.
- (1) Fiberglass Hatch Top Barges. Draw one probe sample from each opening in the direction of the arrow head. Insert the probe in the center of the opening, approximately 7 feet from the side edge.

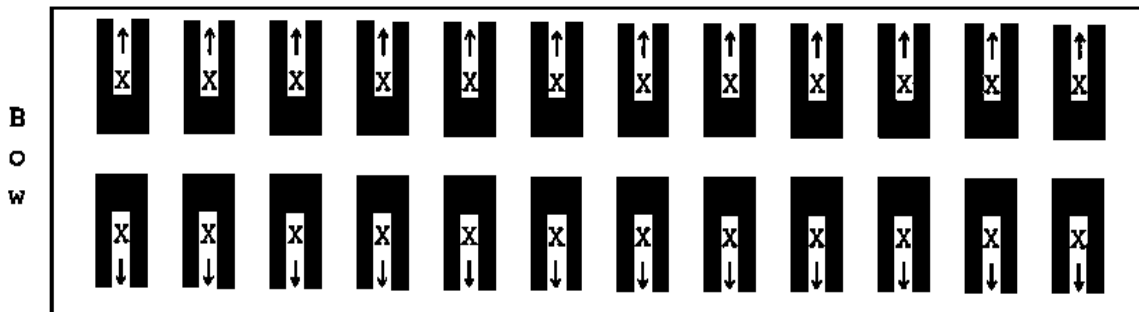


Figure 3. Fiberglass Hatch Top Barge

¹See footnote 1 on page 2-3 and Appendix 1, **Local Quality Control Programs.**

- (2) Lift Top and Roll Top Barges. Draw the first probe approximately 4 feet in from the stern end of the barge and approximately 7 feet from the side. Take the next probe approximately 15 feet from the first probe. Proceed to take probes at 15-foot intervals until the bow end of the barge is reached. The last probe shall be taken approximately 4 feet from the opposite end and approximately 7 feet from the side. Sample both sides of the barge in this manner until the entire barge is sampled.

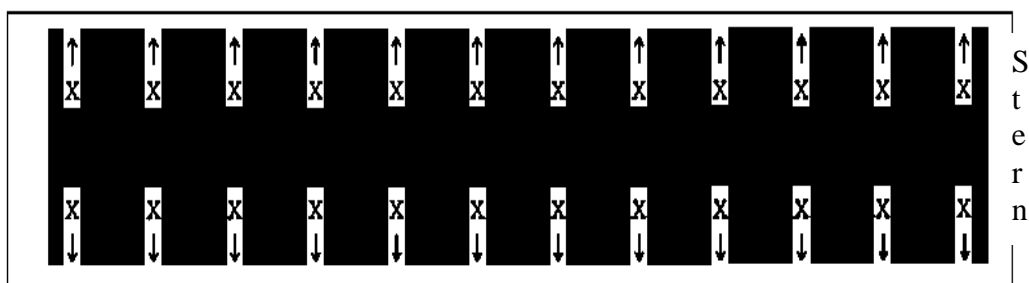


Figure 4. Lift Top and Roll Top Barge

- (3) Other Types of Barges. When sampling barges other than those listed above, use the sampling pattern that will provide the most representative sample.
- (4) Probe Sampling Barges During Loading.
- (a) Using the prescribed pattern, sample up to the point that the barge is fully loaded.
 - (b) Mark this point on the side of the barge.
 - (c) Place the sample in an airtight container.
 - (d) After the next section(s) is loaded, sample from the point marked to the point that loading stopped.
 - (e) Place this sample in a separate container.
 - (f) Repeat the procedure until loading is completed. If all samples are uniform, combine them into one sample.

c. Sampling Patterns for Hopper Cars.

- (1) 3-Compartment, Trough or Door Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle, the probe may be inserted either in the center of each hopper or slightly off center in order to miss the cross beam.

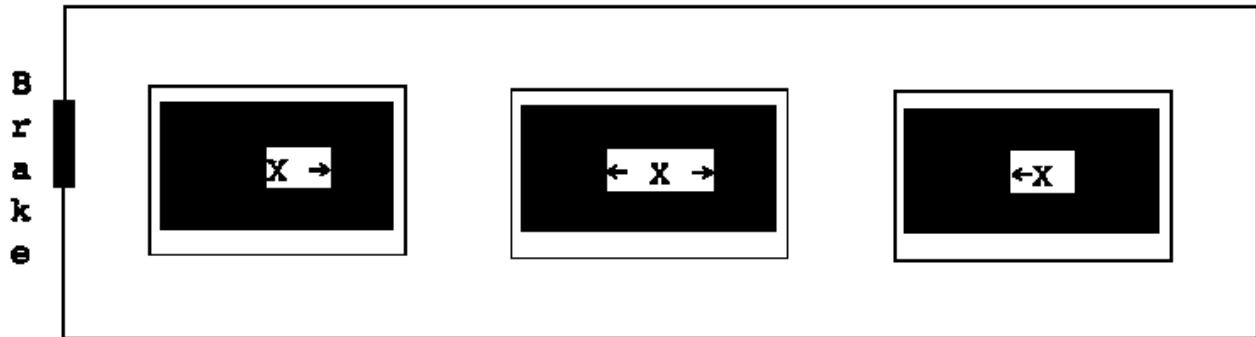


Figure 5. 3-Compartment, Trough or Door Type Hopper Car

- (2) 3-Compartment, 10-Hatch Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle.

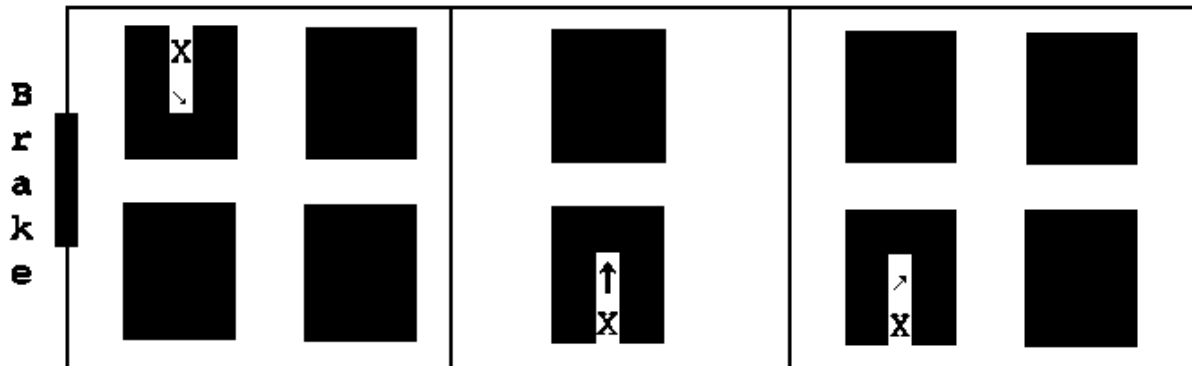


Figure 6. 3-Compartment, 10-Hatch Type Hopper Car

- (3) 2-Compartment, 8-Hatch Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle.

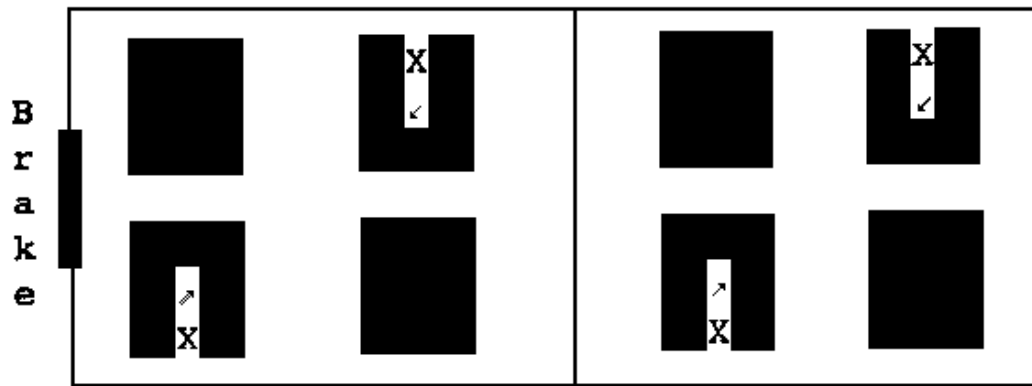


Figure 7. 2-Compartment, 8-Hatch Type Hopper Car

- (4) 2-Compartment, Open Top Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle.

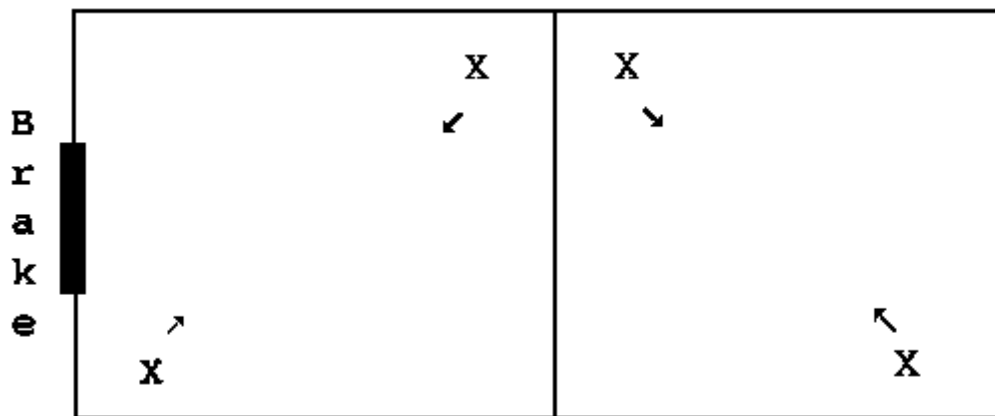


Figure 8. 2-Compartment, Open Top Hopper Car

- (5) 4-Compartment, 12-Hatch Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle.

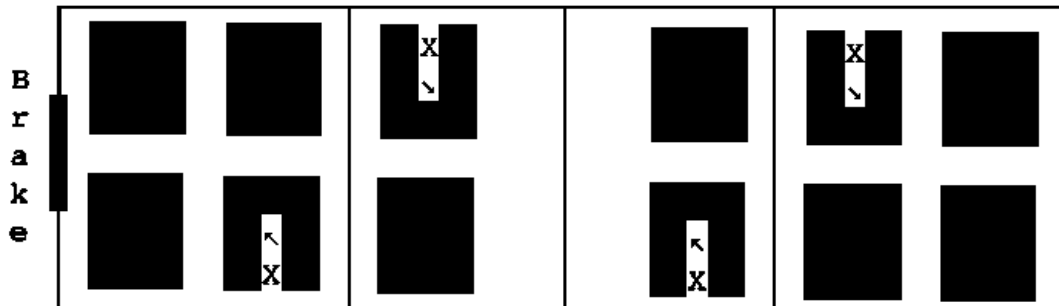


Figure 9. 4-Compartment, 12-Hatch Type Hopper Car

- (6) Articulated Type Hopper Cars. Insert probe in the direction of the arrow at an approximately 10 degree angle.
- Articulated type hopper cars (e.g., "Super Hoppers") are easily recognized because of their configuration. The car's design permanently mounts five, 2-hatch type hopper cars onto 6 sets of wheels. The five car units carry the equivalent of three jumbo hopper cars.
 - Since articulated hopper cars are unique in design, samplers should also be aware that their identification system is different from that of standard hopper cars. Often articulated hopper car units are labeled by the manufacturer. If they are, use this information for identification. If they are not labeled, identify one end unit of the car as the A unit and identify the other end unit as the B unit. Then, identify the three middle units as C, D, and E, going from unit B to unit A. Each unit has two compartments or hoppers. The B-end compartment within a unit is identified as 1 and the A-end unit within the same compartment is identified as 2. See the diagram on page 2-15.

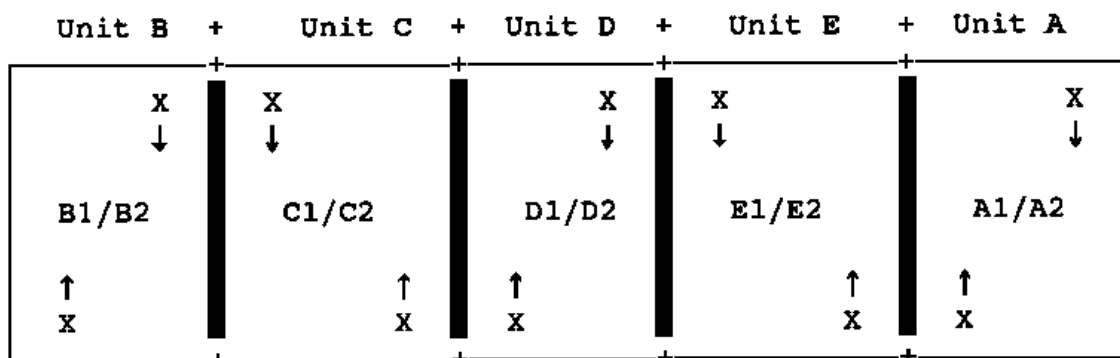


Figure 10. Articulated Type Hopper Car

- (7) Other Types of Hopper Cars. When sampling other types of hopper cars, use the sampling pattern which will provide the most representative sample.
- d. Sampling Pattern for Box Cars. Insert the probe at an approximately 10 degree angle in the direction of the arrows shown in the diagram. The probe pattern shown may also be used in reverse of the one shown.

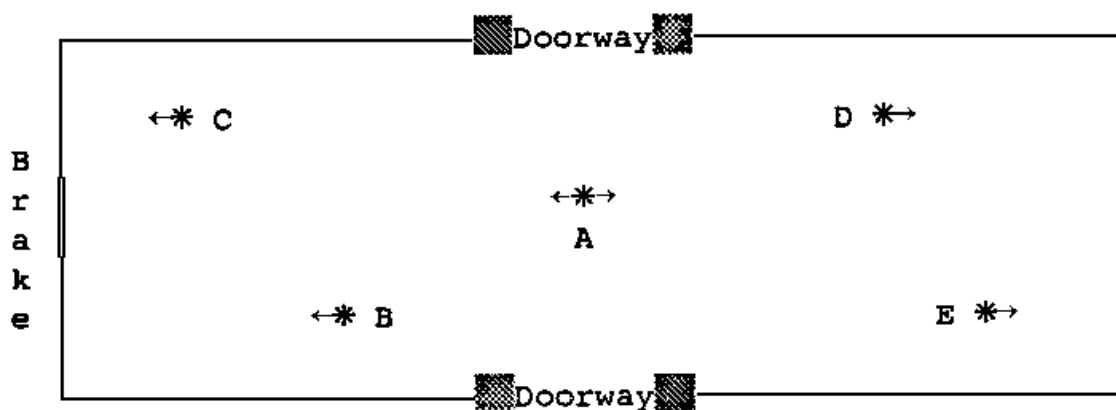


Figure 11. Boxcar

Site A - Draw a sample from the center of the car. The probe may be taken with the slots facing toward either end of the car.

Site B - Draw a sample approximately 3 - 5 feet back from the doorpost and approximately 2 - 4 feet out from the side of car. The slots in the probe face toward the end of the car.

Site C - Draw a sample approximately 3 - 5 feet from the same end of the car and approximately 2 - 4 feet from the opposite side of the car from site B. The slots in the probe face toward the end of the car.

Site D - Draw a sample approximately 3 - 5 feet back from the doorpost and approximately 2 - 4 feet out from the side of car opposite of site B. The slots in the probe face toward the end of the car.

Site E - Draw a sample approximately 3 - 5 feet from the same end of the car and approximately 2 - 4 feet from the opposite side of the car from site D. The slots in the probe face toward the end of the car.

- e. Sampling Patterns for Trucks. Insert the probe at an approximately 10 degree angle in the direction of the arrows shown in the diagram. The probe pattern shown may also be used in reverse of the one shown.
- (1) Flat-Bottom Trucks or Trailers Containing Grain More than 4-Feet Deep or 8 Filled Probe Compartments.

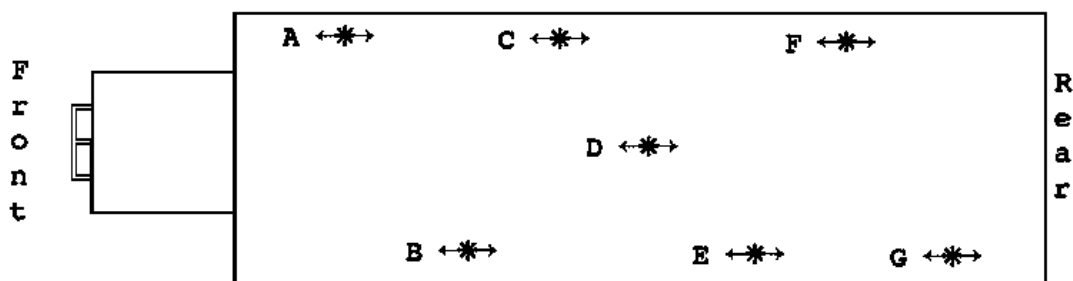


Figure 12. Flat Bottom Truck or Trailer

Site A - Draw a sample approximately 2 feet from the front and side.

Site B - Draw a sample from the opposite side of site A, approximately halfway between the front and center of the carrier, and approximately 2 feet from the side.

Site C - Draw a sample from the same side as site A, approximately $\frac{3}{4}$ (three-fourths) of the distance between the front and center of the truck and approximately 2 feet from the side.

Site D - Draw a sample from the center of the carrier.

Site E - Draw a sample from the side opposite site C, approximately $\frac{3}{4}$ (three-fourths) of the distance between the rear and center, approximately 2 feet from the side.

Site F - Draw a sample from the side opposite site E, approximately one-half the distance between the rear and center, approximately 2 feet from the side.

Site G - Draw a sample from the same side as site E, approximately 2 feet from the rear and side of the carrier.

- (2) Flat-Bottom Trucks or Trailers Containing Grain Less than 4-Feet Deep or Fewer than 8 Filled Probe Compartments.

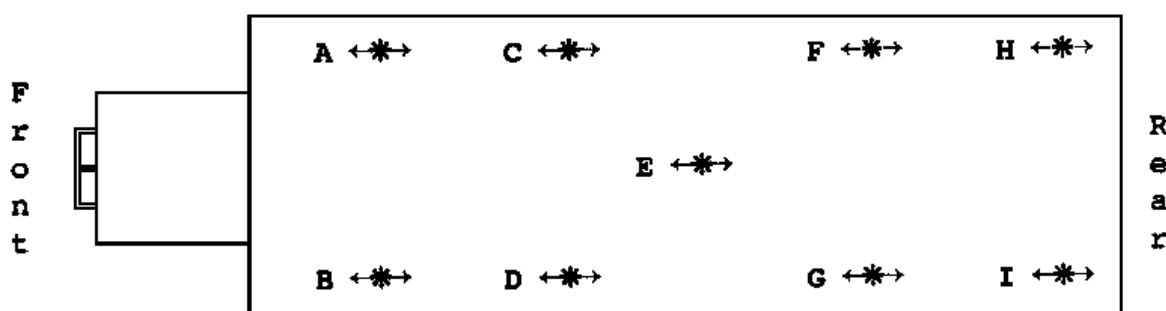


Figure 13. Flat Bottom Truck or Trailer

Site A - Draw a sample approximately 2 feet from the front and side.

Site B - Draw a sample from the opposite side of site A, approximately 2 feet from the side.

Site C - Draw a sample from the same side as site A, approximately $\frac{3}{4}$ (three-fourths) of the distance between the front and center of the truck and approximately 2 feet from the side.

Site D - Draw a sample from the same side as site B, and opposite of site C, approximately $\frac{3}{4}$ (three-fourths) of the distance between the front and center, approximately 2 feet from the side.

Site E - Draw a sample from the center.

Site F - Draw a sample from the same side as site C, approximately $\frac{3}{4}$ (three-fourths) of the distance between the center and rear of the truck and approximately 2 feet from the side.

Site G - Draw a sample from the same side as site D, approximately $\frac{3}{4}$ (three-fourths) of the distance between the center and rear of the truck and approximately 2 feet from the side.

Site H - Draw a sample from the same side as site F, approximately 2 feet from the rear and side of the carrier.

Site I - Draw a sample from the same side as site G, approximately 2 feet from the rear and side of the carrier.

- f. Sampling Pattern for Hopper-Bottom Containers, Trucks, and Trailers. Insert the probe at an approximately 10 degree angle in the direction of the arrows shown in the diagram.

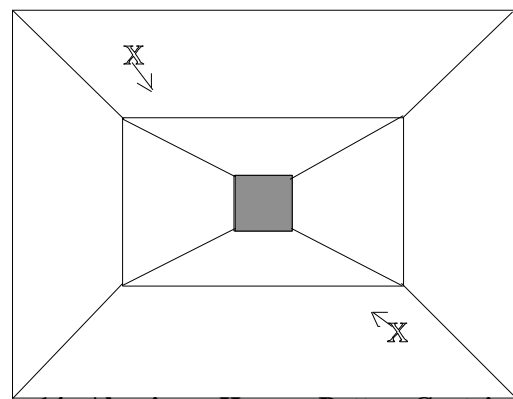


Figure 14. Aluminum Hopper-Bottom Container

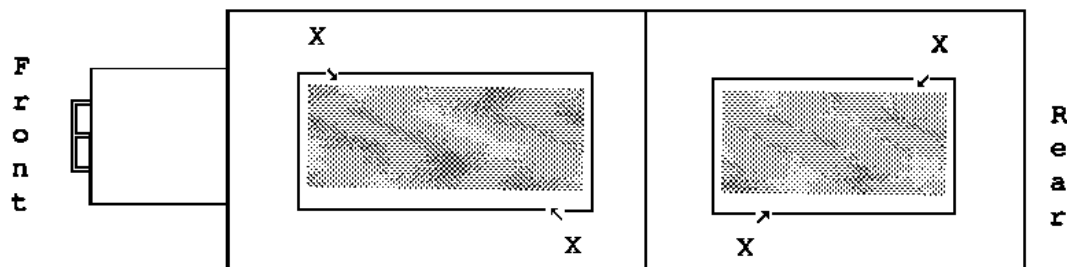


Figure 15. Hopper-Bottom Truck and Trailer

2.5 SAMPLING SACKED GRAIN

When sampling sacked grain, use a double-tubed, compartmented grain probe (minimum length: 4-feet).

CAUTION: When working in warehouses, watch out for forklifts and tow-motors. Also be alert for sacks slipping (falling) from improperly stacked pallets.

- a. Determine the number of sacks in the lot. If the lot contains more than 10,000 sacks, divide the lot into 2 or more (approximately) equal-sized sublots.
- b. For each lot or subplot, randomly select **36** sacks for sampling.

NOTE: All sacks in the lot must be accessible for selection.

- c. Stand each selected sack on end and insert the probe into the top corner of the sack.
- d. Push the probe, with the slots facing upward, diagonally through the sack until the end of the probe touches the opposite bottom corner.
- e. Open the probe, make two quick up-and-down motions, and then close and remove the probe.
- f. Empty the contents of the probe onto a sampling canvas and examine the grain for condition.
- g. If all probe samples are uniform with one another, composite the samples and place into one sample bag.
- h. If the examination of the probe samples indicate that the lot is made up of distinctly different parts in regard to condition, draw a sample from each of the different parts, in addition to the sample as a whole.

NOTE: For more information on the sampling sacked grain, refer to FGIS Instruction 918-41, Sacked Grain.

2.6 PROBE-TYPE MECHANICAL SAMPLER¹

- a. Periodically, examine the sampling system--including the delivery pipes and the sample collection box--to ensure that the system is not clogged-up, leaking, or contains grain and other material from previous lots.
- b. Using the standard sampling pattern (refer to section 2.4), draw one sample from each probe site.

NOTE: If the sampler is not owned by the official agency, it may--at the owner's discretion--be operated by an elevator employee under the direct supervision of official personnel.

- (1) Insert the probe vertically into the grain until it reaches the bottom of the carrier. **Extreme care must be exercised when inserting the probe to prevent damage to the bottom of the carrier--don't continue to exert downward pressure after reaching the bottom.**
- (2) Once the probe has been fully inserted, transfer the sample to the collection box. (Many probes have limit switches that automatically "cycle" the probe and transfer the grain to the collection box.)
- (3) During sampling operations, keep a constant check for possible system malfunctions. Be aware of any change in the sample:

--If the sample flow stops but the vacuum motor is laboring, the delivery system may be plugged;

--If the sample becomes noticeably smaller but the vacuum motor is running freely, the system may have a leak.

NOTE: Carriers with shallow loads may need to have additional probes taken to obtain the proper amount of sample. Draw additional probes in a representative manner; e.g., one portion of a trucklot shall not be probed twice unless the entire truck is probed twice.

- (4) After all samples are drawn, empty the sample collection box and examine the grain for unusual conditions, such as off-odors, heating, infestation, and nonuniformity.

NOTE: Probe-type mechanical samplers are only approved for sampling trucks. Requests for sampling other types of carriers should be forwarded to FGIS Headquarters.

¹See footnote 1 on page 2-3 and Appendix 1, **Local Quality Control Programs.**